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Abstract

A computer system, introduced for use in statistics courses within a college of education, features the performance of a variety of functions, a relatively economic operation, and the facilitation of placing remote terminals in schools. The system provides an interactive statistics laboratory in which the student learns to write programs for the computer in a short course, and uses the computer as a supportive tool to perform lower level cognitive operations. Plans are being made to expand this system to handle computer-assisted learning and information retrieval functions. (SP)

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A COMPUTER SYSTEM FOR A FACULTY OF EDUCATION

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by
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a paper presented to

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* A Computer System for a Faculty of Education

Dr. Whitworth has suggested that the papers given at this Conference are popular and/or technical. I am in something of a quandary to know under which head this paper may be placed. I should like to call it popular were it not for the fact that the ambiguity of the word might appear to make the claim presumptuous. It may in parts appear slightly technical, although I hope it will be everywhere understandable. Certainly it is not offered in order to present the results of empirical research. Rather, it is offered as a straightforward description of the way in which one Faculty of Education is attempting to solve some of the practical problems. relating to the use of computers, which are now facing those of us concerned with Education in universities. It is therefore, my hope that it may produce comments and suggestions useful to our further development of a computer system.

The assumption is that applications of computers in education are inevitably due to increase rapidly. The 1957 report of a U.S. Presidential Committee on Computers in Higher Education suggested that, by the early 1970's, there will be few students in universities or four-year colleges who will not use computers during some part of their course. It was further indicated that learning to program a computer should be regarded as of approximately the same level of difficulty as learning to drive a car. It may be expected that within a relatively short time there will be extensive use of computers in high schools, and in junior high schools. Numerous computers are already installed in schools.

I assume that faculties of education should at least keep up with the schools and with other parts of the universities. Preferably, I suppose, they should be attempting to initiate change by introducing new computer applications relevant to education. Those of us concerned with teacher training should therefore be planning to introduce our students to such applications.

With these considerations in mind, it would appear that any computer system established within a faculty of education should:

First perform a variety of functions
Second be as economic as possible, and
Third be such that it will facilitate the placing of terminals remotely in the schools.

These considerations have been kept in mind when developing our system in Calgary.

1967-68. System of Programs. FORTRAN

By the 1967-68 session, the use of computers had already been introduced into all statistics courses within our Faculty. This was done by means of a system of computer programs developed by Mrs. Brebner and myself for the naive user. Making use of this system, we find it is possible to teach students to make practical use of computers within not more than three hours of instruction.

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* CCRE is pleased to bring you this paper. The ideas expressed are those of the author.

The first hour is used for a general description of computers. The second hour is taken up by a visit to the computer installation within the University, and by an introduction to the use of the key punch. During the third hour students are taught to use our system of programs, and are then expected to prepare cards to run a set of test data. When this has been done successfully, they are expected to run a real example, preferably using data obtained from a school or school system.

Thereafter, in teaching statistics, we adopt a standard procedure. When a particular statistical process has been taught, an example is first run on a desk calculator. The same example is then run through the computer, and, following this, real data are processed on the computer.

In the more advanced statistical courses, FORTRAN is taught and is used for the writing of small programs.

Needs

Having reached this position, we decided that we had need for a time-sharing system using remote consoles for a variety of purposes:

1. We needed terminals which could be used as superior desk calculators.
2. It should also be possible to use such terminals to call into operation previously written statistical programs for all the major processes which we teach.
3. The terminals should also make it possible for students to learn computer programming on-line in a high-level language.
4. They should also be available for computer assisted learning and for simulation.
5. Hopefully, they should eventually be available for purposes of information retrieval.
6. Also, it should be possible to place the terminals remotely, so that we could begin using CAL and teaching the use of computers in schools.

We consider that we have gone a long way towards solving these problems at a relatively economic cost.

Computer System Now Installed

We have now installed a Digital Equipment Corporation TSS-8 system which will eventually have 12K of core memory and a 250K random access disk. This system is capable of expansion for up to thirty-two teletypes on a time-shared basis. Initially, however, it will support no more than eight teletypes within the Education Building. Also attached to it by 'phone line, will be a basic 8-I, with 4K of core memory, located in a trailer. In this trailer will eventually be a further four teletypes, also supported by the TSS-8 system.

Each of the teletypes, both in the Education Building and in the trailer, will be located on a student station, having a random access slide projector with computer control, and, hopefully, a speech synthesizer under computer control. Provision will also be made on each station for the later installation, as required, of film projectors or video-tape projectors.

The TSS-8 system will be linked by co-axial cable to the University 360 computer.

We shall therefore have the stand-alone TSS-8 system within the Faculty Building, also a stand-alone 8-I system in a trailer which we shall be able to locate near a school. The 8-I in the trailer will be generally linked by 'phone line to the TSS-8 system. The TSS-8 system in turn will be linked when necessary by co-axial cable to the 360 computer, thus giving the whole system greater power and far greater memory capacity.

1. Interactive Statistics Laboratory

This system will provide us with an interactive statistics laboratory in connection with courses taught within the Faculty.

As a student sits at one of the teletypes, he will appear to have a 4K 8-I computer to himself. He will therefore be able to use his teletype as a superior desk calculator. To do this, he will make use of the Digital Equipment Corporation high-level on-line language called FOCAL, in "direct" mode. Alternatively, he will be able to use the more commonly employed language BASIC. Either of these languages can be used almost immediately for simple operations.

The student will also be able to use this terminal in "indirect" mode. That is, he will be able to call into operation standard statistical programs which we have written and stored as part of our system of programs. We already have these available, for example, for descriptive statistics (including the printing of a histogram on the teletype), means, standard deviations, a correlation matrix for up to ten variables, t-tests for both correlated and uncorrelated means, and one-way and two-way analysis of variance. The indications are that it will be possible to extend this system of programs quite rapidly.

This will enable to student to learn, and to make use of, statistics in a way not previously possible. He will be able to process real data on line, and to gain experience of the use of various operations in realistic situations.

I suggested at the CCRE Conference on Educational Technology in November 1966 that computers should be used as tools to aid thinking - to perform lower level cognitive operations whilst the student concentrates on higher-level operations. The intention is to use the terminal in this matter in statistics courses.

2. Learning of Computer Programming

Further, the student will be able to learn with very little difficulty to write his own programs. We estimate that it will be possible for a student to begin writing programs in FOCAL or BASIC almost immediately, and that three hours of experience at a terminal will make him quite a good programmer.

The system also allows the writing of programs on-line in FORTRAN II. However, it is doubtful whether we shall make use extensively of this facility when we have FOCAL and BASIC available.

Several ASSEMBLER languages will also be operational in time-sharing mode. Obviously, these will be more efficient as a means of using the machine, but will also take rather longer to learn and require greater effort in the production of a program. We therefore envisage that only our more expert programmers will make much use of these languages.

It is perhaps worth emphasizing that a student writing a program while sitting at an on-line terminal learns far more, far more quickly, than he does when there is only a batch processing system available to him. In the TSS-8 system we consider that we have probably the most economic on-line time-sharing system available anywhere.

3. Computer Assisted Learning and Simulation

When we come to consider the provision of computer assisted learning or simulation, in either school or university, the first obstacle appears at the present time to be cost. To date, teletypes have been far more economic than any other terminal device. As I have already indicated, we therefore intend to use our teletypes on computer assisted learning stations.

Using FOCAL, we have already written several programs to give drill in arithmetic. We have also written a version of the Sumerian game devised by IBM and the Westchester School Board at Yorktown Heights. In each case, the writing of the programs was remarkably easy for a person with some previous experience in programming. However, there are limitations. FOCAL as presently available allows too small a memory for each student, particularly when it is necessary to print out messages on the teletype. Also, it is somewhat difficult to devise tutorial type programs in this language since it is difficult to deal with the input of words from a teletype.

The obvious solution is to write the programs in ASSEMBLER language, and this we have already started to do. However, we immediately meet the usual difficulty: there are not at the present time enough people who know ASSEMBLER languages well, and the learning of these is more time-consuming.

Our need is for a high level language for CAL purposes, one which works on the 360 machine and is transmitted via the data lines already indicated to the TSS-8 and 8-I systems. Mr. Brown and Mr. Brahan of NRC have kindly helped us here by providing their CATSYS system programmed in PL-1. We are presently making this operational on the 360 computer and we hope to have it working through to our TSS-8 and 8-I systems in the near future.

Perhaps I should indicate that with our TSS-8 system we shall always have a time-sharing monitor. When we have written a computer assisted learning program or a simulation program, in a language such as FOCAL or BASIC or ASSEMBLER, this can be stored on the disk and will be immediately available to any of the teletypes. In the case of the 8-I in the trailer, however, the monitor will have to be modified to time-share among the four terminals in the trailer.

The hardware interfacing for the random access slide projectors is presently being built, and the time-sharing system will require relatively little modification if any, in order to work both teletypes and random access slide projectors.

4. Information Retrieval

We hope ultimately to link the TSS-8 system into an information retrieval system operational on the 360 computer. At the present time, we are thinking in terms of Vinsonhaler's system, BIRS, or, if the University purchases

the Informatics system, we shall use this.

Similarly, we would intend to use the link to the 360 to transmit data to the system of statistical programs which we shall continue to operate on the larger machine.

5. CAL and Programming in the Schools

Finally, as I have already indicated, we shall be able to locate at least four terminals near a school. These will be available for CAL.

We also intend to use them to teach FOCAL and/or BASIC to allow students to devise algorithmic solutions to mathematical problems as in the CAMP project.

Conclusion

The system I have described is reasonably economic and very flexible. It is not a particularly large and powerful system. However, the PDP-8 machines, which are the predecessors of the system we are using, have already been employed in computer assisted learning projects at Stanford, by the National Research Council of Canada, and as terminals for the RCA Spectra computer system used by the New York School Board. Sometimes they have been used as stand-alone systems, sometimes as intelligent terminals to a larger machine.

The TSS-8 system itself is now being introduced into schools in the U.S.

We therefore consider that, with the additions and modifications indicated in this paper, we have the beginning of a system which can be extended to perform a variety of functions which are required both by a faculty of education, and by schools, at the present time.